

06/10/98
 3532 U.S. PTO

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PTO/SB/05 (12/97)
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UTILITY PATENT APPLICATION TRANSMITTAL	Attorney Docket No.	INPA:060	Total Pages	31
	First Named Inventor or Application Identifier			
	Ronald L. Mosgrove			
	Express Mail Label No.	EM139337595US		

(Only for new nonprovisional applications under 37 CFR 1.53(b))

APPLICATION ELEMENTS See MPEP chapter 600 concerning utility patent application contents	ADDRESS TO: Assistant Commissioner for Patents Box Patent Application Washington, DC 20231
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1. <input checked="" type="checkbox"/> Fee Transmittal Form <i>(Submit an original, and a duplicate for fee processing)</i> 2. <input checked="" type="checkbox"/> Specification [Total Pages <u>26</u>] <i>(preferred arrangement set forth below)</i> - Descriptive title of the Invention - Cross References to Related Applications - Statement Regarding Fed sponsored R & D Invention - Reference to Microfiche Appendix - Background of the Invention - Brief Summary of the Invention - Brief Description of the Drawings <i>(if filed)</i> - Detailed Description - Claim(s) - Abstract of the Disclosure 3. <input checked="" type="checkbox"/> Drawing(s) (35 USC 113) [Total Sheets <u>5</u>] 4. <input type="checkbox"/> Oath or Declaration [Total Pages <u> </u>] a. <input type="checkbox"/> Newly executed (original or copy) b. <input type="checkbox"/> Copy from a prior application (37 CFR 1.63(d)) <i>(for continuation/divisional with Box 17 completed)</i> [Note Box 5 below] i. <input type="checkbox"/> DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b). 5. <input type="checkbox"/> Incorporation By Reference (useable if Box 4b is checked) The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.	6. <input type="checkbox"/> Microfiche Computer Program (Appendix) 7. Nucleotide and/or Amino Acid Sequence Submission <i>(if applicable, all necessary)</i> a. <input type="checkbox"/> Computer Readable Copy b. <input type="checkbox"/> Paper Copy (identical to computer copy) c. <input type="checkbox"/> Statement verifying identity of above copies <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> Accompanying Application Parts 8. <input type="checkbox"/> Assignment Papers (cover sheet & document(s)) 9. <input type="checkbox"/> 37 CFR 3.73(b) Statement <input type="checkbox"/> Power of Attorney <i>(when there is an assignee)</i> 10. <input type="checkbox"/> English Translation Document <i>(if applicable)</i> 11. <input type="checkbox"/> Information Disclosure <input type="checkbox"/> Copies of IDS Statement (IDS)/PTO-1449 Citations 12. <input type="checkbox"/> Preliminary Amendment 13. <input checked="" type="checkbox"/> Return Receipt Postcard (MPEP 503) <i>(Should be specifically itemized)</i> 14. <input type="checkbox"/> Small Entity <input type="checkbox"/> Statement filed in prior application, Statement(s) Status still proper and desired 15. <input type="checkbox"/> Certified Copy of Priority Document(s) <i>(if foreign priority is claimed)</i> 16. <input checked="" type="checkbox"/> Other Unexecuted Declaration (2 pages); Check for 1526.00 </div>
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17. If a CONTINUING APPLICATION, check appropriate box and supply the requisite information:

☐ Continuation ☐ Divisional ☒ Continuation-in-part (CIP) of prior application No: 08 / 998,583

18. CORRESPONDENCE ADDRESS

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CITY	Houston	STATE	Texas	ZIP CODE	77057-2132
COUNTRY	U.S.A.	TELEPHONE	(713) 787-1635	FAX	(713) 787-1440

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FEE TRANSMITTAL		Complete if Known	
		Application Number	08/998,583
		Filing Date	12/29/97
		First Named Inventor	Ronald L. Mosgrove
		Group Art Unit	2751
		Examiner Name	Unknown
TOTAL AMOUNT OF PAYMENT		(\$) 1526.00	
Attorney Docket Number		INPA:060/PYL	

<p>METHOD OF PAYMENT (check one)</p> <p>1. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge indicated fees and credit any over payments to</p> <p>Deposit Account Number 01-2508/INPA:060/PYL</p> <p>Deposit Account Name Arnold, White & Durkee</p> <p><input checked="" type="checkbox"/> Charge Any Additional Fee Required Under 37 CFR 1.16 and 1.17 <input type="checkbox"/> Charge the Issue Fee Set in 37 CFR 1.18 at the Mailing of the Notice of Allowance, 37 CFR 1.31(b)</p> <p>2. <input checked="" type="checkbox"/> Payment Enclosed:</p> <p style="padding-left: 40px;"><input checked="" type="checkbox"/> Check <input type="checkbox"/> Money Order <input type="checkbox"/> Other</p> <p style="text-align: center;">FEE CALCULATION (fees effective 10/01/97)</p> <p>1. FILING FEE</p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Large Entity</th> <th style="text-align: left;">Small Entity</th> <th></th> <th></th> </tr> <tr> <th>Fee Code</th> <th>Fee (\$)</th> <th>Fee Code</th> <th>Fee (\$)</th> </tr> </thead> <tbody> <tr> <td>101</td> <td>790</td> <td>201</td> <td>395</td> </tr> <tr> <td>106</td> <td>330</td> <td>206</td> <td>165</td> </tr> <tr> <td>107</td> <td>540</td> <td>207</td> <td>270</td> </tr> <tr> <td>108</td> <td>790</td> <td>208</td> <td>395</td> </tr> <tr> <td>114</td> <td>150</td> <td>214</td> <td>75</td> </tr> <tr> <td colspan="2"></td> <td colspan="2" style="text-align: right;">SUBTOTAL (1)</td> </tr> <tr> <td colspan="2"></td> <td colspan="2" style="text-align: right;">(\$) 790.00</td> </tr> </tbody> </table> <p>2. CLAIMS</p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th></th> <th>Extra</th> <th>Fee from below</th> <th></th> <th>Fee Paid</th> </tr> </thead> <tbody> <tr> <td>Total Claims 46 -20 =</td> <td>26</td> <td>X 22.00</td> <td>=</td> <td>572.00</td> </tr> <tr> <td>Independent 5 - 3 =</td> <td>2</td> <td>X 82.00</td> <td>=</td> <td>164.00</td> </tr> <tr> <td>Claims</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Multiple Dependent Claims 0</td> <td>X</td> <td>-----</td> <td>=</td> <td>0</td> </tr> </tbody> </table> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Large Entity</th> <th style="text-align: left;">Small Entity</th> <th></th> <th></th> </tr> <tr> <th>Fee Code</th> <th>Fee (\$)</th> <th>Fee Code</th> <th>Fee (\$)</th> </tr> </thead> <tbody> <tr> <td>103</td> <td>22</td> <td>203</td> <td>11</td> </tr> <tr> <td>102</td> <td>82</td> <td>202</td> <td>41</td> </tr> <tr> <td>104</td> <td>270</td> <td>204</td> <td>135</td> </tr> <tr> <td>109</td> <td>82</td> <td>209</td> <td>41</td> </tr> <tr> <td>110</td> <td>22</td> <td>210</td> <td>11</td> </tr> <tr> <td colspan="2"></td> <td colspan="2" style="text-align: right;">SUBTOTAL (2)</td> </tr> <tr> <td colspan="2"></td> <td colspan="2" style="text-align: right;">(\$) 736.00</td> </tr> </tbody> </table>	Large Entity	Small Entity			Fee Code	Fee (\$)	Fee Code	Fee (\$)	101	790	201	395	106	330	206	165	107	540	207	270	108	790	208	395	114	150	214	75			SUBTOTAL (1)				(\$) 790.00			Extra	Fee from below		Fee Paid	Total Claims 46 -20 =	26	X 22.00	=	572.00	Independent 5 - 3 =	2	X 82.00	=	164.00	Claims					Multiple Dependent Claims 0	X	-----	=	0	Large Entity	Small Entity			Fee Code	Fee (\$)	Fee Code	Fee (\$)	103	22	203	11	102	82	202	41	104	270	204	135	109	82	209	41	110	22	210	11			SUBTOTAL (2)				(\$) 736.00		<p>3. 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SUBMITTED BY		Complete (if applicable)	
Typed or Printed Name	Jeffrey A. Pyle	Reg Number	34,904
Signature		Date	6/10/98
		Deposit Acct User ID	INPA:060/PYL

06/10/98
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WRITER'S DIRECT DIAL:
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RE: *New Application for Patent*

Dear Sir:

Transmitted herewith for filing is the patent application of Inventor Ronald L. Mosgrove for: METHOD AND APPARATUS FOR ROBUST ADDRESSING ON A DYNAMICALLY CONFIGURABLE BUS, a continuation-in-part of pending Application Serial No. 08/998,583, filed on December 29, 1997, from which claims the earlier effective filing date.

Enclosed are the following documents:

- X Completed Utility Patent Application Transmittal Form;
- X Completed Fee Transmittal Form;
- X Declaration (unexecuted);
- X A 26-page specification, 46 claims (6 pages), and an abstract of the disclosure.
- X Drawings (Figures 1-12; on 6 pages); and
- X A postcard. Please date stamp and return the enclosed postcard to evidence receipt of these materials.

BOX PATENT APPLICATION

June 10, 1998

Page 2

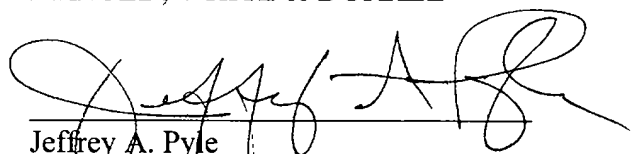
<u>CLAIMS AS FILED</u>		<u>Small Entity</u>		<u>Other than Small Entity</u>	
Total Claims	46 - 20 =	x \$ 11	= <u>26</u>	or x \$ 22 =	572
Independent Claims	5 - 2 =	x \$ 40	= <u>3</u>	or x \$ 80 =	164.00
Multiple Dependent Claims Presented		+ \$ 130	= <u> </u>	or + \$ 260 =	-0-
Basic Fee			\$385	or \$ 770 =	<u>\$1526.00</u>
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Please address all correspondence in connection with this application to: Jeffrey A. Pyle, Arnold, White & Durkee, P.O. Box 4433, Houston, Texas 77210-4433, Telephone (713) 787-1400.

Very truly,

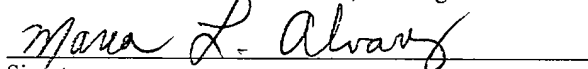
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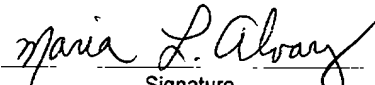
Application for United States Letters Patent

for

**METHOD AND APPARATUS FOR ROBUST ADDRESSING ON A
DYNAMICALLY CONFIGURABLE BUS**

by

Ronald L. Mosgrove

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METHOD AND APPARATUS FOR ROBUST ADDRESSING ON A DYNAMICALLY CONFIGURABLE BUS

BACKGROUND OF THE INVENTION

This application is a continuation-in-part of my co-pending application Serial No. 08/998,583, entitled "Method and Apparatus for Robust Addressing on a Dynamically Configurable Bus," filed December 29, 1997, from which I claim the benefit of an earlier effective filing date for all common subject matter.

1. FIELD OF THE INVENTION

This invention relates generally to bus systems and, more particularly, to robust addressing on a dynamically configurable bus.

2. DESCRIPTION OF THE RELATED ART

A "bus" is a group of transmission media used to pass information from one location to another. One type of bus is a collection of wires used to transmit data and control information to the various internal components of a computer. Another type of bus is a collection of wires, fibers, or cables, used to transmit data and control information between "bus devices" such as computers, printers, and magnetic tape drives. As used herein, the term "bus" shall refer to the latter type of bus.

The bus devices and the bus comprise a "bus system." Exemplary applications for bus systems include universal serial bus ("USB") systems and Ethernet local area networks ("LANs") that, in turn, might comprise part of larger wide area networks ("WANs"). A bus may be used to implement a LAN, but not all bus systems are actual computer networks in the sense of a LAN. An bus system might simply be a group of devices on a bus wherein the bus is a channel

among the devices. Thus, the term “bus system” as used herein shall encompass a group of bus devices transmitting and/or receiving information over a bus. The definition may encompass a LAN depending on the particular implementation.

5 A bus system, therefore, typically includes a bus to which several bus devices are coupled. Each bus device has a physical address on the bus at which it receives and/or from which it transmits information over the bus. Thus, a computer may transmit information over the bus from its physical address to a shared printer at the printer’s physical address, provided both are part of the same
10 bus system.

Historically, every bus device had a predetermined, unique, physical address on the bus to prevent confusion during information transmission. Because the physical address was predetermined and static, a device could assume
15 that a particular device was, in fact, located at that address. In the recited example, the computer could send the information to the printer at the printer’s assigned physical address confident that only the printer would receive or respond because only the printer would reside at the assigned physical address.

20 However, the use of physical addressing imposed certain constraints on bus system design. These constraints were eventually overcome using a technique known as “virtual addressing.” Under this approach, a bus device operates on the bus using its “virtual address,” which is associated with, but typically different from, its physical address. Virtual addressing nevertheless created a serious
25 addressing problem: a device could no longer assume the presence or absence of another device from its virtual address because it differed from the device’s physical address.

Typically, when a device wishes to communicate with another device over
30 a virtually addressed bus, the communicating bus device at some point queries all

the other bus devices until it finds the one with which it wishes to communicate. More particularly, the querying device accesses the bus one or more times to examine the configuration information for each device encountered. The querying device determines from the configuration information whether the encountered device is the one sought. If so, the physical address is retrieved and the communication conducted. Otherwise, the querying device continues on to the next bus device until it locates the desired bus device.

This propagation of addressing information requires substantial overhead, burdens the bus system and consumes system resources that otherwise might be used more productively. In addition, the propagation of addressing information potentially produces user visible delays or interruption of services. Thus, although this approach works satisfactorily with small numbers of bus devices, it is unduly burdensome for large bus systems.

The overhead problem is exacerbated when the dynamic bus system includes power-managed bus devices. A power-managed device switches to a "sleep" state to reduce power consumption after a predetermined period of non-use. Many bus devices have limited capabilities for tracking certain events in the reconfiguration in dynamically configurable bus systems. The difficulty arises when the dynamic bus system is reconfigured and a device of this type is in the sleep state. Such devices cannot track dynamic events in the sleep state and must be awakened to do so, thereby hampering power management.

The present invention is directed to overcoming, or at least reducing the effects of, one or more of the problems set forth above.

SUMMARY OF THE INVENTION

The invention, in one particular embodiment is a bus system, comprising a dynamically configurable bus, a first bus device on the bus at a first virtual

address and at a first physical address on the bus, and a second bus device on the bus at a second virtual address and a second physical address. The bus system further comprises a map of the first and second virtual addresses to the first and second physical addresses, respectively, encoded on a program storage medium, the map being accessible over the bus.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and advantages of the invention will become apparent upon reading the following detailed description and upon reference to the drawings in which:

Figure 1 illustrates a first embodiment of a bus system constructed and operated in accordance with the present invention;

Figure 2 illustrates a method for operating the bus system of Figure 1 in accordance with the particular embodiment of the invention therein;

Figure 3 illustrates a change in configuration of the bus system in Figure 1 such as might trigger the method of Figure 2;

Figure 4 illustrates one particular embodiment of the bus system in Figure 3;

Figure 5 illustrates a second embodiment of the invention, the embodiment being a dynamically configurable bus system including a bus manager;

Figure 6 illustrates one embodiment of a method as may be employed by the dynamically configurable bus system of Figure 5 in accordance with the present invention;

Figure 7 depicts the insertion or removal of a bus device from the dynamic bus system of Figure 5;

Figure 8 depicts one particular embodiment of the dynamic bus system illustrated in Figure 7; and

Figure 9 illustrates a second particular embodiment of the dynamically configurable bus system of Figure 7 including a second bus manager;

Figure 10 illustrates a third embodiment of the invention, the embodiment being a bus system including two separate buses coupled by a bridge;

Figure 11 illustrates a method as may be performed by the embodiment of Figure 10 in accordance with the present invention; and

Figure 12 depicts one particular embodiment of the bus system of Figure 10.

While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof have been shown by way of example in the drawings and are herein described in detail. It should be understood, however, that the description herein of specific embodiments is not intended to limit the invention to the particular forms disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION OF SPECIFIC EMBODIMENTS

Illustrative embodiments of the invention are described below. In the interest of clarity, not all features of an actual implementation are described in this specification. It will of course be appreciated that in the development of any such actual embodiment, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which will vary from one implementation to another. Moreover, it will be appreciated that such a development effort, even if complex and time-consuming, would be a routine undertaking for those of ordinary skill in the art having the benefit of this disclosure.

Figure 1 illustrates a bus system 10 constructed and operated in accordance with a first embodiment of the invention. The system 10 generally

comprises a dynamically configurable bus 12, a first bus device 14, and a second bus device 16. The first bus device 14 and the second bus device 16 may be coupled to the bus 12 in a conventional manner. The first bus device 14 includes a map 18, whose structure and function are set forth in more detail below.

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The bus 12 may be any type of dynamically configurable bus and, in various alternative embodiments, may comprise multiple buses. The bus 12 may, in some embodiments, implement a LAN or part of a WAN (not shown). The bus 12 may, therefore, be any medium suitable for a particular implementation such as a twisted wire pair, a coaxial cable, or an optical fiber. The bus 12 may operate in accord with any number of standards or protocols known to the art for this purpose, provided modifications are made to implement the invention as set forth below.

The first bus device 14 may be any one of a number of bus device types appropriately programmed and as are known in the art. For instance, the first bus device 14 may be an appropriately programmed personal computer or workstation in various alternative embodiments. The first bus device 14 has a memory subsystem (not shown) that includes some form of program storage device such as a random access memory ("RAM"), a hard disk, a floppy disk, or an optical disk. Some embodiments of the first bus device 14 might have more than one program storage device.

The first bus device 14 constructs and maintains the address map 18. The address map 18 maps a virtual address for each bus device to the respective physical address for that bus device. Virtual addressing is well known in the art. Before communication may be established, the physical address associated with the virtual address must be ascertained. Thus, a virtual address is assigned to each of the first bus device 14 and the second bus device 16 in a manner known to the art. In the embodiment illustrated, the map 18 maps the virtual addresses of the

first bus device 14 and the second bus device 16 to their respective physical addresses on the bus system 10. The map 18 is bi-directional so that a physical address may be located from a virtual address and a virtual address can be located from a physical address.

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The map 18 may be implemented as a data structure encoded on some form of random access memory (not shown) such as an optical disk, a hard disk or a floppy disk. Many suitable data structures are known to the art. For instance, the map 18 may be implemented as any type of storage mechanism, such as an array, a doubly linked list, a tree, a table, or a simple file, provided the structure suitably enables the bi-directional determination of virtual addresses and physical addresses. The particular structure with which the map 18 is implemented is not material to the practice of the invention, although some particular implementations might favor one structure over another.

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In some embodiments, the map 18 will be implemented by an “address manager.” The address manager may be a software application resident on some program storage medium associated with the first bus device 14. For instance, the address manager may comprise computer readable instructions encoded on a program storage medium (not shown) such as a random access memory, a hard disk, a floppy disk, or an optical disk. The address manager, in such embodiments, would gather the necessary information and create the data structure that comprises the map 18.

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The map 18 is shown resident on the first bus device 14 in Figure 1. Although this has many advantages, it is not necessary to the practice of the invention. The map 18 may be stored on any bus device having suitable capabilities that may be accessed over the bus 12. The entire map 18 also need not be resident on a single bus device, but may be distributed across a plurality of bus devices in some embodiments.

30

Figure 2 illustrates one embodiment of a method performed in accordance with the present invention. The method of Figure 2 is performed whenever a “configuration event” occurs on the bus system 10. On virtually addressed buses, only certain activities may cause addresses to change. These activities will be called “configuration events.”

Configuration events such as powering on a bus, resetting a bus, insertion or removal of a device or any other event defined by the protocols appropriate for the bus implementation that may cause physical addresses to change. Configuration events are typically well known so that affected devices have the capability to detect that the configuration event has occurred. Physical addresses are static between configuration events, configuration events being the occasions on which the map 18 is generated and stored. Referring now to Figure 3, a third bus device 19 is illustrated in ghosted lines, indicating its insertion into or removal from the bus system 10. Any such insertion or removal will cause a configuration event on the bus system 10. Any configuration event will invoke the method of Figure 2.

Referring to both Figure 2 and Figure 3, the method begins by querying, upon detection of a configuration event, each one of the bus devices 16 and 19 other than the first bus device 14 and determining the identity of each queried bus device 16 and 19 from their configuration information. Each bus device 14, 16, and 19 has a virtual address and a physical address assigned to it in the manner customarily used in the art. From the device’s identity, the first bus device 14 ascertains the virtual address and the physical address for the devices 16 and 19. The first bus device 14 then maps the virtual address for each of the bus devices 16 and 19 to the physical address therefore. This map 18 is then stored and can then be used whenever any bus device 14, 16, or 19 wishes to transmit to another over the bus 12.

As will be apparent to those skilled in the art having the benefit of this disclosure, the invention is particularly suited to address the problems earlier mentioned. The construction and maintenance of the map alleviates the need to propagate physical addressing information as a bus device may simply access the map. Individual devices furthermore are relieved of the necessity to constantly track all dynamic events in lieu of the mapping activities. Thus, sleeping bus devices may continue to sleep through dynamic events. Still other advantages may accrue through use of the invention.

Figure 4 depicts a bus system 20 that is one particular embodiment of the bus system 10 in Figure 1. The bus system 20 includes a workstation 22, a printer 24, and a magnetic tape drive 26, all electrically coupled to a dynamically configurable bus 28. The term “workstation” is used herein in both a specific and a general sense. Specifically, the workstation 22 is a workstation in the sense of a dedicated, applications oriented computer with high resolution graphics capability. However, in embodiments where the bus system 20 implements a LAN, the workstation 22 may be a workstation in the sense of a single-user computer on the LAN. In the particular embodiment illustrated, the dynamically configurable bus 28 implements a network that may be a LAN or part of a WAN (not shown).

The workstation 22 is appropriately programmed and includes a floppy disk drive 32 and an optical disk drive 34 into which a floppy disk 36 and an optical disk 38, respectively, may be inserted. The memory subsystem of the workstation 22 also includes a hard disk (not shown) and RAM (also not shown). The floppy disk 36 is a program storage device on which the map 18, shown in Figure 1, may be stored once constructed. The optical disk 38 is a program storage device on which the instructions for implementing the invention may be stored.

5 The workstation 22 constructs and maintains the address map, which may be encoded on any part of the memory subsystem discussed above. The address map maps a virtual address for each bus device 24, 26 to the respective physical address for that bus device. The particular virtual address for each bus device in this embodiment is the device's "guaranteed unique identifier." GUIDs and their use are well known in the art and, in addition to being unique, are guaranteed to be constant. GUIDs are typically installed by the manufacturer and never changed afterward.

10 The printer 24 and the magnetic tape drive 26 are merely representative bus devices. Other types of bus devices, such as a video camera, may be employed in other embodiments. In the embodiment of Figure 4, neither the printer 24 nor the magnetic tape drive 26 has the capability to manage the bus 28, although the workstation 22 does. However, this is not necessary to the practice of the invention and such capability need not be employed in all embodiments.

15 Before communication may be established with a bus device, the physical address associated with the virtual address must be ascertained. Thus, a virtual address is assigned to each of the workstation 22, the printer 24, and the magnetic tape drive 26 in a manner known to the art. In the embodiment illustrated, the map maps the virtual addresses of the workstation 22, the printer 24, and the magnetic tape drive 26 to their respective physical addresses on the bus system 20. The map is bi-directional so that a physical address may be located from a virtual address and a virtual address can be located from a physical address.

25 The map may be implemented as a data structure encoded on some form of random access memory such as the hard disk (not shown) and the floppy disk 36. The map may be implemented using any type of data storage technique, such as an array, a doubly linked list, a tree, a table, or a simple file, provided the structure suitably enables the bi-directional determination of virtual addresses and

physical addresses. In this particular embodiment, the map is implemented by an address manager resident on the hard disk of the workstation 22. The address manager gathers the necessary information and creates the data structure that comprises the map.

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Referring to both Figure 2 and Figure 4, the method begins by querying, upon detection of a configuration event, each one of the bus devices, *i.e.*, workstation 22, printer 24, and magnetic tape drive 26 is queried to determine the identity of each queried bus device 24 and 26. Each bus device 22, 24, and 26 has a virtual address and a physical address assigned to it in the manner customarily used in the art. From the device's identity, the workstation 22 ascertains the virtual address and the physical address for the devices 24 and 26. The workstation 22 then maps the virtual address for each of the bus devices 24 and 26 to the physical address therefore. This map 18 is then stored and can then be used whenever any bus device 22, 24, or 26 wishes to transmit to another over the bus 12.

15

The invention may also, in some alternative embodiments, be employed in a dynamically configurable bus system including a bus manager. Figure 5 illustrates a dynamically configurable bus system 40 including a bus manager. The system 40 generally comprises a dynamically configurable bus 42, a bus device 44 operating as a bus manager, and a bus device 46. The bus manager 44 and the bus device 46 are coupled to the dynamically configurable bus 42 in a conventional manner. The map 48 resides on the bus manager 44, whose structure and function are set forth in more detail below.

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The dynamically configurable bus 42 may be any type of bus and may, in some embodiments, implement a LAN or part of a WAN (not shown). The dynamically configurable bus 42 may, therefore, be any medium suitable for a particular implementation such as a twisted wire pair, a coaxial cable, or an

30

optical fiber. The bus may operate in accord with any number of standards or protocols known to the art for this purpose, provided modifications are made to implement the invention as set forth below.

5 The bus manager 44 manages the bus, performing arbitration, allocation, and control as defined in the standards and protocols known to the art for this purpose and appropriate for the specific implementation. The bus manager 44 may be any of a number of bus device types appropriately programmed for this function and as are known in the art. For instance, the bus manager 44 may be an
10 appropriately programmed personal computer or workstation in various alternative embodiments. The bus manager 44 has a memory subsystem (not shown) that includes some form of program storage device such as a random access memory ("RAM"), a hard disk, a floppy disk, or an optical disk. Some embodiments of the bus manager 44 might have more than one program storage
15 device.

 The bus manager 44 constructs and maintains the address map 48. The address map 48 maps a virtual address for each bus device to the respective physical address for that bus device. The virtual address for any given bus device
20 44 or 46 in this particular embodiments is also its GUID. A GUID is assigned to each of the bus manager 44 and the bus device 46 in a manner known to the art. In the embodiment illustrated, the map 48 maps the GUIDs of the bus manager 44 and the bus device 46 to their respective physical addresses on the dynamic bus system 40. The map 48 is bi-directional so that a physical address may be located
25 from a GUID and a GUID can be located from a physical address.

 The map 48 may be implemented as a data structure encoded on some form of random access memory such as a hard disk or a floppy disk. Many suitable data structures are known to the art. For instance, the map 48 may be
30 implemented as any type of storage mechanism, such as an array, a doubly linked

list, a tree, a table, or a simple file, provided the structure suitably enables the bi-directional determination of GUIDs and physical addresses. The particular structure with which the map 48 is implemented is not material to the practice of the invention, although some particular implementations might favor one structure over another.

In some embodiments, the map 48 will be implemented by an "address manager." The address manager may be a software application resident on some program storage medium associated with the bus manager 44. For instance, the address manager may comprise computer readable instructions encoded on a program storage medium (not shown) such as a random access memory, a hard disk, a floppy disk, or an optical disk. The address manager, in such embodiments, would gather the necessary information and create the data structure that comprises the map 48.

The map 48 is shown resident on the bus manager 44 in Figure 5. Although this has many advantages, it is not necessary to the practice of the invention. The map 48 may be stored on another bus device, such as an external hard disk (not shown), that may be accessed over the dynamically configurable bus 42. Similarly, in embodiments employing an address manager, the address manager may advantageously be employed resident on the bus manager 44. The invention nevertheless contemplates that an address manager might be resident on another bus device from which it may be invoked over the dynamically configurable bus 42 upon power-on or reset.

Figure 6 illustrates one embodiment of a method performed in accordance with the present invention. The method of Figure 6 is performed whenever a configuration event, as earlier described, occurs on the bus system 40, configuration events being the occasions on which the map 48 is generated and stored. Referring now to Figure 7, a bus device 49 is illustrated in ghosted lines,

indicating its insertion into or removal from the bus system 40. Any such insertion or removal will cause a configuration event on the bus system 40. Any configuration event will invoke the method of Figure 6.

Referring to both Figure 6 and Figure 7, the method begins by querying, upon detection of a configuration event, each one of the bus devices 46 and 49 other than the bus manager 44 and determining the identity of each queried device 46 and 49 from their configuration information. Each device 44, 46, and 49 has a GUID and a physical address assigned to it in the manner customarily used in the art. From the device's identity, the bus manager 44 ascertains the GUID and the physical address for the devices 46 and 49. The bus manager 44 then maps the GUID for each of the bus devices 46 and 49 to the physical address therefore. This map 48 is then stored and can then be used whenever any bus device 44, 46, or 49 wishes to transmit to another over the dynamically configurable bus 42.

Figure 8 depicts a dynamically configurable bus system 50 that is one particular embodiment of the bus system 40 in Figure 5. The bus system 50 includes a workstation 52, a printer 54, and a magnetic tape drive 56, all electrically coupled to a dynamic bus 58. The workstation 52 acts as the bus manager in this particular embodiment. The workstation 52 includes a floppy disk drive 60 and an optical disk drive 62 into which a floppy disk 64 and an optical disk 66, respectively, may be inserted. The floppy disk 64 is a program storage device on which the map 48, shown in Figure 5, may be stored. The optical disk 66 is a program storage device on which the instructions for implementing the invention may be stored. The printer 54 and the magnetic tape drive 56 are merely representative bus devices and other types of bus devices may be employed.

Referring to both Figure 6 and Figure 8, the method begins by querying, upon detection of a configuration event, each one of the bus devices 54 and 56

other than the bus manager 52 and determining the identity of each queried bus device 54 and 56 from their configuration information. Each bus device 52, 54, and 56 has a virtual address and a physical address assigned to it in the manner customarily used in the art. From the device's identity, the bus manager 52 ascertains the virtual address and the physical address for the devices 54 and 56. The bus manager 52 then maps the virtual address for each of the bus devices 54 and 56 to the physical address therefore. This map is then stored and can then be used whenever any bus device 52, 54, or 56 wishes to transmit to another over the bus 58.

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Figure 9 illustrates a particular embodiment in which a dynamic bus system 70 includes two potential bus managers 72. Each of the potential bus managers 72 is a workstation such as the workstation 52 in Figure 8. The two workstations 72 in Figure 9 may each have the ability to be a bus manager, but only one may be bus manager at any given time. As will be appreciated by those skilled in the art having the benefit of this disclosure, the two workstations 72 will arbitrate each time the bus system 70 is reset or powered on to determine which will be the bus manager. The designated bus manager then remains bus manager until the next power-on or reset, at which time the workstations 72 re-arbitrate. The bus system 70 in Figure 9 otherwise operates in a manner analogous to that of the embodiments in Figures 5-7.

The invention may also, in alternative embodiments, be employed in bus systems employing multiple buses. Figure 10 illustrates such a bus system 80. The bus system 80 includes a first bus device 82 on a bus 86 with a second bus device 84. The bus 86 comprises two buses 83 and 84 physically coupled by bridge 85 in a conventional manner. The map 89 is shown residing on the first bus device 82. However, the first bus device 82, second bus device 84, and the map 89 are subject to all the variations disclosed relative to the alternative embodiments discussed above. Thus, one or more of the bus devices 82 and 84

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may be a bus manager, but neither has to be. Similarly, the map 89 may reside on either of the bus devices 82 and 84 or the bridge 85, or be distributed among them.

5 The principle difference in the operation of the bus system 80 relative to other bus systems discussed above is that configuration events may occur on either of the buses 83 and 87. Thus, the map 89 might need to be constructed for events occurring on a bus to which the bus device 82 is directly coupled. The nature of these configuration events will be implementation specific since many variations on the coupled-bus embodiment of Figure 10 are possible. These variations and the associated configurations events will be readily apparent to those skilled in the art having the benefit of this disclosure.

15 Note, however, that the map 89 would need to be constructed only for the bus 83 or 87 experiencing the configuration event. For example, if bus device 84 were removed from the bus 86, and more particularly bus 84, the map 89 would only need to be reconstructed for those bus devices on the bus 87. The map 89 could remain unaltered for the bus devices on the bus 83. Alternatively, the map 89 may be reconstructed for the entire bus 86 upon detecting a reconfiguration event on either of the buses 83 and 87.

25 Figure 11 illustrates one embodiment of a method performed in accordance with the present invention. The method of Figure 2 is performed whenever a "configuration event" occurs on the bus system 80, regardless of whether such configuration event occurs on bus 83 or bus 87. Some configuration events might affect both buses 83 and 87; for example, a power on of the bus system 86. However, for the sake of clarity, the method of Figure 11 shall be discussed assuming a configuration event on the buses 87. Application of the method 11 to a configuration event affecting bus 83 only or both buses 83 and 87

will be readily extrapolated from the discussion below by those skilled in the art having the benefit of this disclosure.

Referring to both Figure 10 and Figure 11, the method is invoked by the
5 detection of a configuration event on either of the buses 83 and 87. Upon such
detection, the method of Figure 11 begins by querying each one of the bus devices
85 and 84 other than the first bus device 82 on the bus experiencing the
configuration event. Next, the identity of each queried bus device 84 and 85 is
determined from their configuration information. Each bus device 82, 84, and 85
10 has a virtual address and a previously physical address assigned to it in the
manner customarily used in the art. From the device's identity, the first bus
device 82 ascertains the virtual address and the physical address for the queried
devices 84 and 85. The first bus device 82 then maps the virtual address for each
of the queried bus devices 84 and 85 to the physical address therefore. This map
15 89 is then stored and can then be used whenever any bus device 82, 84, or 85
wishes to transmit to another over the bus 86.

Figure 12 illustrates bus system 90, which is one particular embodiment of
the bus system 80 of Figure 10.. The bus system 90 includes a workstation 92 and
20 a printer 94 coupled to a bus 96. The bus 96 includes a first bus 98 coupled by a
bridge 100 to a second bus 102. The workstation 92 includes a memory
subsystem including a hard disk (not shown), RAM (not shown), a floppy disk
104, and an optical disk 106. As with other embodiments discussed above, the
hard drive, floppy disk 104, and the optical disk 106 may be encoded with
25 instructions for executing the method of the invention in its various alternative
embodiments. Note, however, that the bridge 100 will have a virtual address and
a physical address that will need to be mapped.

Referring now to both Figure 10 and Figure 11, the method is invoked by
30 the detection of a configuration event on either of the buses 98 and 102. Again,

for the sake of clarity, the method of Figure 11 shall be discussed assuming a configuration event on the buses 102. Upon such detection, the method of Figure 11 begins by querying each one of the bus devices 100 and 94 other than the first bus device 92 on the bus 102 experiencing the configuration event. Next, the identity of each queried bus device 94 and 100 is determined from their configuration information. Each bus device 92, 94, and 100 has a virtual address and a previously physical address assigned to it in the manner customarily used in the art. From the device's identity, the first bus device 92 ascertains the virtual address and the physical address for the queried devices 94 and 100. The first bus device 92 then maps the virtual address for each of the queried bus devices 94 and 100 to the physical address therefore. This map 89 is then stored and can then be used whenever any bus device 92, 94, or 100 wishes to transmit to another over the bus 96.

Thus, the particular embodiments disclosed above are illustrative only, as the invention may be modified and practiced in different but equivalent manners apparent to those skilled in the art having the benefit of the teachings herein. Furthermore, no limitations are intended to the details of construction or design herein shown, other than as described in the claims below. It is therefore evident that the particular embodiments disclosed above may be altered or modified and all such variations are considered within the scope and spirit of the invention. Accordingly, the protection sought herein is as set forth in the claims below.

CLAIMS

WHAT IS CLAIMED:

1. A bus system, comprising:
a dynamically configurable bus;
5 a first bus device on the bus at a first virtual address and at a first physical address
on the bus;
a second bus device on the bus at a second virtual address and a second physical
address; and
a map of the first and second virtual addresses to the first and second physical
10 addresses, respectively, encoded on a program storage medium, the map
being accessible over the bus.
2. The bus system of claim 1, wherein at least one of the first and second
virtual addresses is a guaranteed unique identifier.
3. The bus system of claim 1, where in the map resides on at least one of the
15 first and second bus devices.
4. The bus system of claim 1, wherein at least one of the first and second bus
devices is a bus manager.
5. The bus system of claim 4, wherein the bus manager comprises one of a
workstation and a personal computer
- 20 6. The bus system of claim 4, wherein the map is stored on the bus manager.
7. The bus system of claim 1, wherein the bus system implements a network.
8. The bus system of claim 1, wherein at least one of the first and second bus
devices is selected from the group comprising a printer, a plotter, a workstation, a
personal computer, a video camera, and a magnetic tape drive.

9. The bus system of claim 1, wherein the map is encoded as a structure selected from the group of an array, a doubly linked list, a tree, a table, and a file.

10. The bus system of claim 1, wherein the map is bi-directional.

11. The bus system of claim 1, wherein the bus includes:

- 5 a first dynamically configurable bus; and
a second dynamically configurable bus.

12. The bus system of claim 11, wherein the first and second buses are coupled by a bridge.

13. A dynamically configurable bus system, comprising:

- 10 a dynamically configurable bus;
a plurality of bus devices coupled to the bus, each one of the plurality of bus devices having a virtual address and a physical address, at least one of the plurality of bus devices mapping at least one virtual address to the respective physical address for the bus device associated with the
15 respective physical address.

14. The bus system of claim 13, wherein at least one of the first and second virtual addresses is a guaranteed unique identifier.

15. The bus system of claim 13, wherein the map resides on at least one of the first and second bus devices.

20 16. The bus system of claim 13, wherein at least one of the first and second bus devices is a bus manager.

17. The bus system of claim 16, wherein the bus manager comprises one of a workstation and a personal computer.

25 18. The bus system of claim 16, wherein the map is stored on the bus manager.

19. The bus system of claim 13, wherein the bus system implements a network.

20. The bus system of claim 13, wherein at least one of the first and second bus devices is selected from the group comprising a printer, a plotter, a workstation, a personal computer, a video camera, and a magnetic tape drive.

21. The bus system of claim 13, wherein the map is encoded as a structure selected from the group of an array, a doubly linked list, a tree, a table, and a file.

22. The bus system of claim 13, wherein the map is bi-directional.

23. The bus system of claim 13, wherein the bus includes:
a first dynamically configurable bus; and
a second dynamically configurable bus.

24. The bus system of claim 23, wherein the first and second buses are coupled by a bridge.

25. A program storage device encoded with instructions that, when executed by a computer, map a plurality of virtual addresses to the respective physical addresses for a plurality of bus devices in a dynamically configurable bus system upon detecting a configuration event.

26. The program storage device of claim 25, wherein each virtual address and the respective physical address is mapped into at least one of an array, a doubly linked list, a tree, a table, and a file.

27. The program storage device of claim 25, wherein the mapping of a plurality of virtual addresses to the respective physical addresses includes:
querying each one of the plurality of the bus devices other than the bus manager;
identifying each queried device from the configuration information therefore;
ascertain the virtual address and the physical address for each identified device;

constructing a map of the virtual address for each of the plurality of bus devices to
the physical address therefore; and
storing the map.

28. The program storage device of claim 27, wherein the map comprises at
5 least one of an array, a doubly linked list, a tree, a table, and a file.

29. The program storage device of claim 25, wherein the dynamically
configurable bus comprises a first dynamically configurable bus and a second
dynamically configurable bus and the act of mapping a plurality of virtual addresses to
the respective physical addresses is performed only for the bus devices on the particular
10 one of the first and second dynamically configurable buses experiencing a configuration
event.

30. The program storage device of claim 25, wherein the encoded instructions,
when executed, map the virtual addresses to the respective physical addresses bi-
directionally.

31. The program storage device of claim 25, wherein the mapped virtual
15 address is a guaranteed unique identifier.

32. The program storage device of claim 25, wherein at least one of the
plurality of bus devices is a bus manager.

33. A method for robust addressing on a bus including a plurality of bus
20 devices, one of the bus devices being a bus manager, the method comprising:

querying each one of the plurality of the bus devices other than the bus manager;
identifying each queried device from the configuration information therefore;
ascertaining the virtual address and the physical address for each identified
device;

25 mapping the virtual address for each of the plurality of bus devices to the physical
address therefore; and

storing the map.

34. The method of claim 33, wherein the querying each one of the plurality of devices includes querying at least one of a printer, a plotter, a workstation, a personal computer, a video camera, and a magnetic tape drive.

5 35. The method of claim 33, wherein the bus manager comprises one of a workstation and a personal computer.

36. The method of claim 33, wherein storing the map includes storing the map on the bus manager.

37. The method of claim 33, wherein mapping the virtual address for each of
10 the plurality of bus devices to the physical address therefore includes mapping each virtual address and the respective physical address into at least one of an array, a doubly linked list, a tree, a table, and a file.

38. The method of claim 33, wherein mapping the virtual address for each of
15 the plurality of bus devices to the physical address therefore includes bi-directionally mapping the virtual address for each of the plurality of bus devices to the physical address therefore.

39. The method claim 33, wherein the dynamically configurable bus
comprises a first dynamically configurable bus and a second dynamically configurable bus and the act querying is performed only for the bus devices on the particular one of the
20 first and second dynamically configurable buses experiencing a configuration event.

40. A program storage device encoded with instructions that, when executed by a computer, perform the method comprising:

querying each one of the plurality of the bus devices other than the bus manager;
identifying each queried device from the configuration information therefore;
25 ascertain the virtual address and the physical address for each identified device;

mapping the virtual address for each of the plurality of bus devices to the physical address therefore; and
storing the map.

41. The program storage device of claim 40, wherein querying each one of the plurality of devices in the method includes querying at least one of a printer, a plotter, a workstation, a personal computer, a video camera, and a magnetic tape drive.

42. The program storage device of claim 40, wherein the bus manager comprises one of a workstation and a personal computer.

43. The program storage device of claim 40, wherein storing the map in the method includes storing the map on the bus manager.

44. The program storage device of claim 40, wherein mapping the virtual address for each of the plurality of bus devices to the physical address therefore in the method includes mapping each virtual address and the respective physical address into at least one of an array, a doubly linked list, a tree, a table, and a file.

45. The program storage device of claim 40, wherein mapping the virtual address for each of the plurality of bus devices to the physical address therefore in the method includes bi-directionally mapping the virtual address for each of the plurality of bus devices to the physical address therefore.

46. The method claim 40, wherein the dynamically configurable bus comprises a first dynamically configurable bus and a second dynamically configurable bus and the act querying is performed only for the bus devices on the particular one of the first and second dynamically configurable buses experiencing a configuration event.

ABSTRACT OF THE DISCLOSURE

5 The invention, in one particular embodiment is a bus system, comprising a bus, a first bus device on the bus at a virtual address and at a first physical address on the bus, and a second bus device on the bus at a second virtual address and a second physical address. The bus system further comprises a map of the first and second virtual addresses to the first and second physical addresses, respectively, encoded on a program storage medium, the map being accessible over the bus.

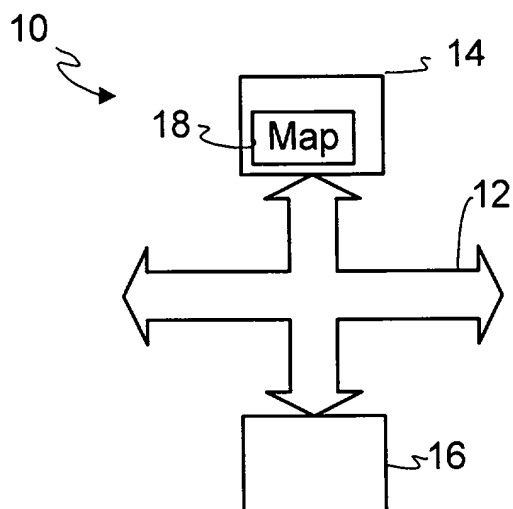


Fig. 1

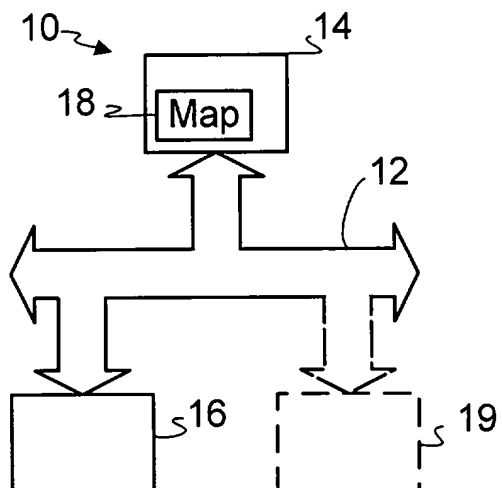


Fig. 3

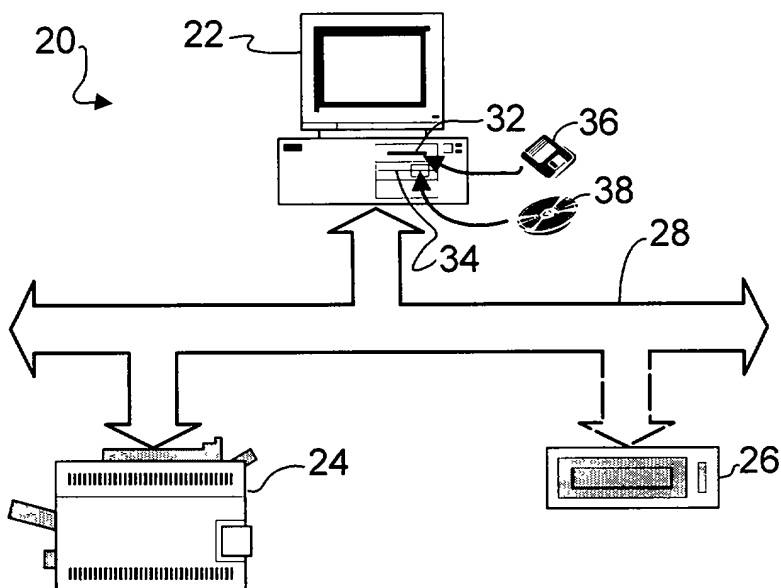
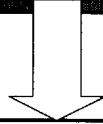
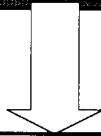


Fig. 4

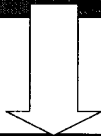
Query each one of the
bus devices other than
the bus manager



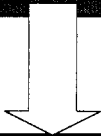
Identify each queried device from the
configuration information therefore



Ascertain from each device's
identity the virtual address and the
physical address therefore



Map the virtual address for each of
the plurality of bus devices to the
physical address therefore



Store the map

Fig. 2

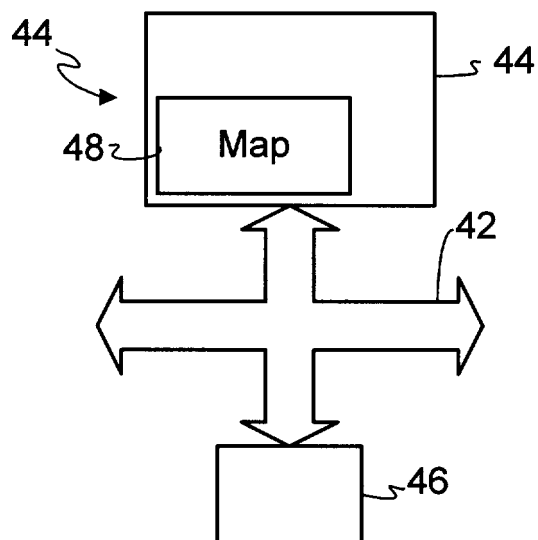


Fig. 5

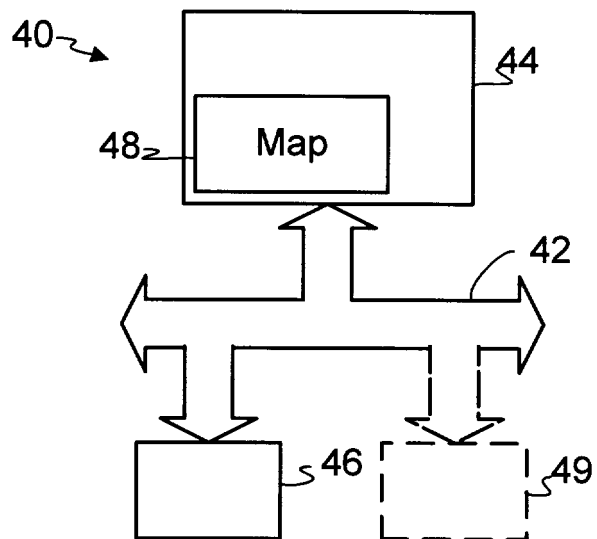


Fig. 7

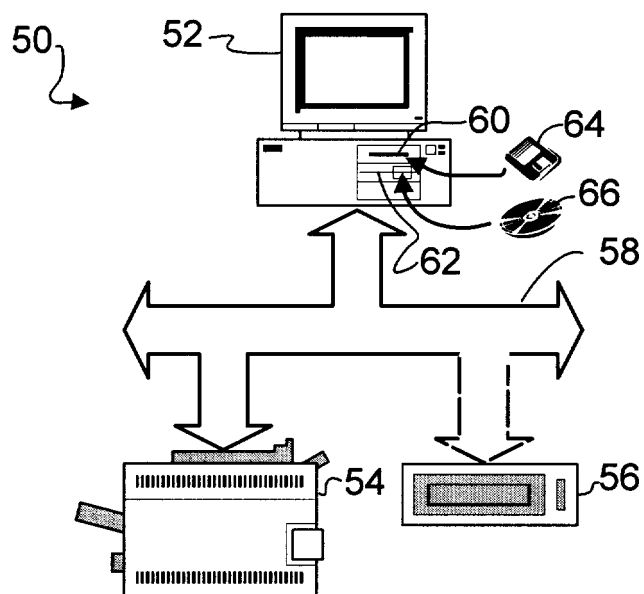


Fig. 8

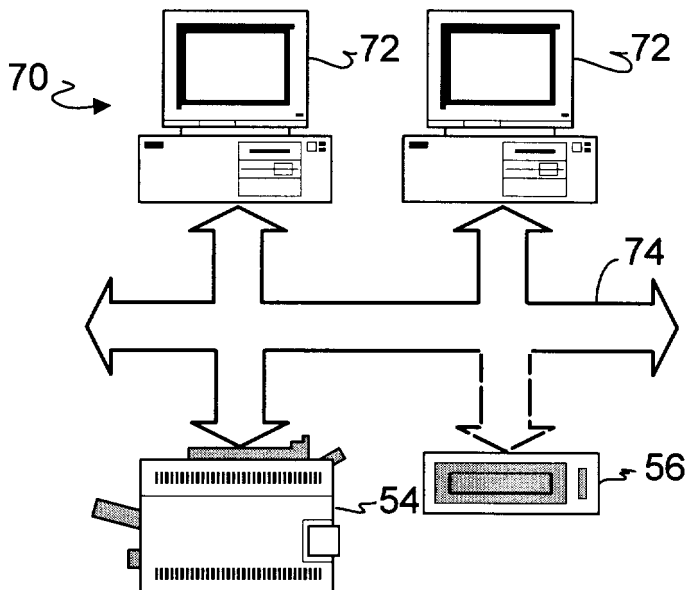
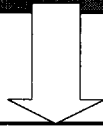
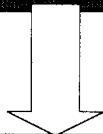


Fig. 9

Query each one of the bus devices on the bus experiencing the configuration event other than the bus manager



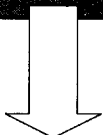
Identify each queried device from the configuration information therefore



Ascertain from each queried device's identity the virtual address and the physical address therefore



Map the virtual address for each of the queried bus devices to the physical address therefore



Store the map

Fig. 11

DECLARATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or the below named inventors are the original, first and joint inventors (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **METHOD AND APPARATUS FOR ROBUST ADDRESSING ON A DYNAMICALLY CONFIGURABLE BUS**, the Specification of which:

- ☒ is attached hereto.
☐ was filed on _____ as Application Serial No. _____

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims.

I acknowledge the duty to disclose to the Patent and Trademark Office all information known to me to be material to patentability of the subject matter claimed in this application, as "materiality" is defined in Title 37, Code of Federal Regulations, § 1.56.

I hereby claim priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent, United States provisional application(s), or inventor's certificate listed below and have also identified below any foreign application for patent, United States provisional application, or inventor's certificate having a filing date before that of the application on which priority is claimed:

PRIORITY APPLICATION(S)			Priority Claimed
(Number)	(Country)	(Date Filed)	Yes/No
(Number)	(Country)	(Date Filed)	Yes/No

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose all information known to me to be material to patentability of the subject matter claimed in this

application, as "materiality" is defined in Title 37, Code of Federal Regulations, § 1.56, which become available between the filing date of the prior application and the national or PCT international filing date of this application:

08/998,583	12/29/97	Pending
(Application Serial No.)	(Filing Date)	(Status)
(Application Serial No.)	(Filing Date)	(Status)

I hereby direct that all correspondence and telephone calls be addressed to Jeffrey A. Pyle, Arnold, White & Durkee, P.O. Box 4433, Houston, Texas 77210, (713) 787-1400.

I HEREBY DECLARE THAT ALL STATEMENTS MADE OF MY OWN KNOWLEDGE ARE TRUE AND THAT ALL STATEMENTS MADE ON INFORMATION AND BELIEF ARE BELIEVED TO BE TRUE; AND FURTHER THAT THESE STATEMENTS WERE MADE WITH THE KNOWLEDGE THAT WILLFUL FALSE STATEMENTS AND THE LIKE SO MADE ARE PUNISHABLE BY FINE OR IMPRISONMENT, OR BOTH, UNDER SECTION 1001 OF TITLE 18 OF THE UNITED STATES CODE AND THAT SUCH WILLFUL FALSE STATEMENTS MAY JEOPARDIZE THE VALIDITY OF THE APPLICATION OR ANY PATENT ISSUED THEREON.

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